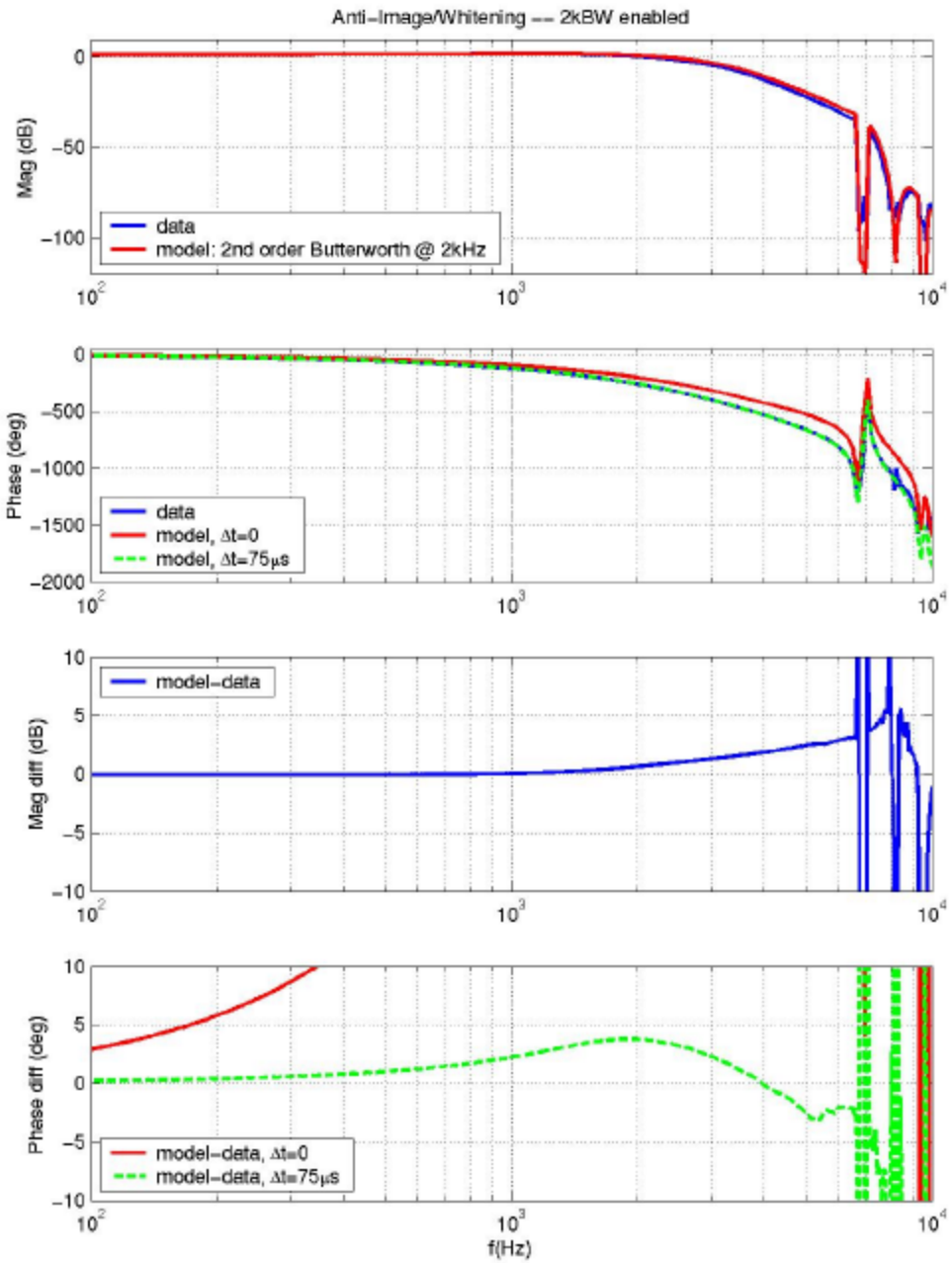
LSC Characterization and Modeling

Goals:

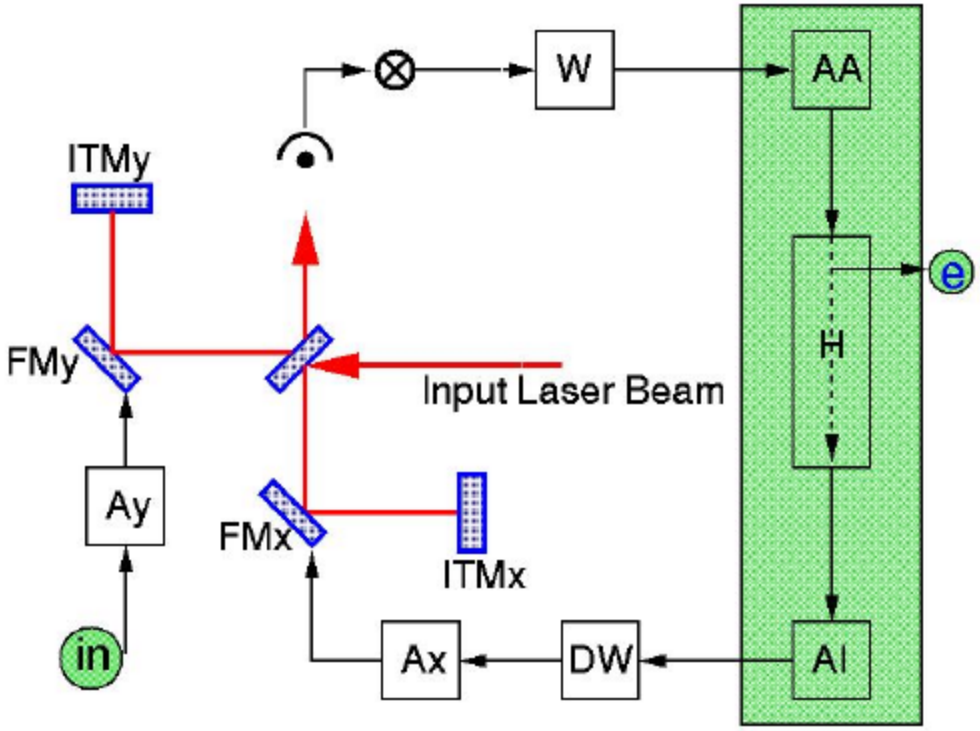
- Model consistent with observations?
  - » Test with the “simplest” optical configuration;
- Account for phase in arms
  - » Closed loop TF measurements;

- Recall…
  - » Estimated the computation delay by
    - – Comparing TF AI/W with a model of W x AA x AI x (2kBW sampled @ 16khz)
    - – Fit phase by adjusting the delay parameter
- -> 75us delay



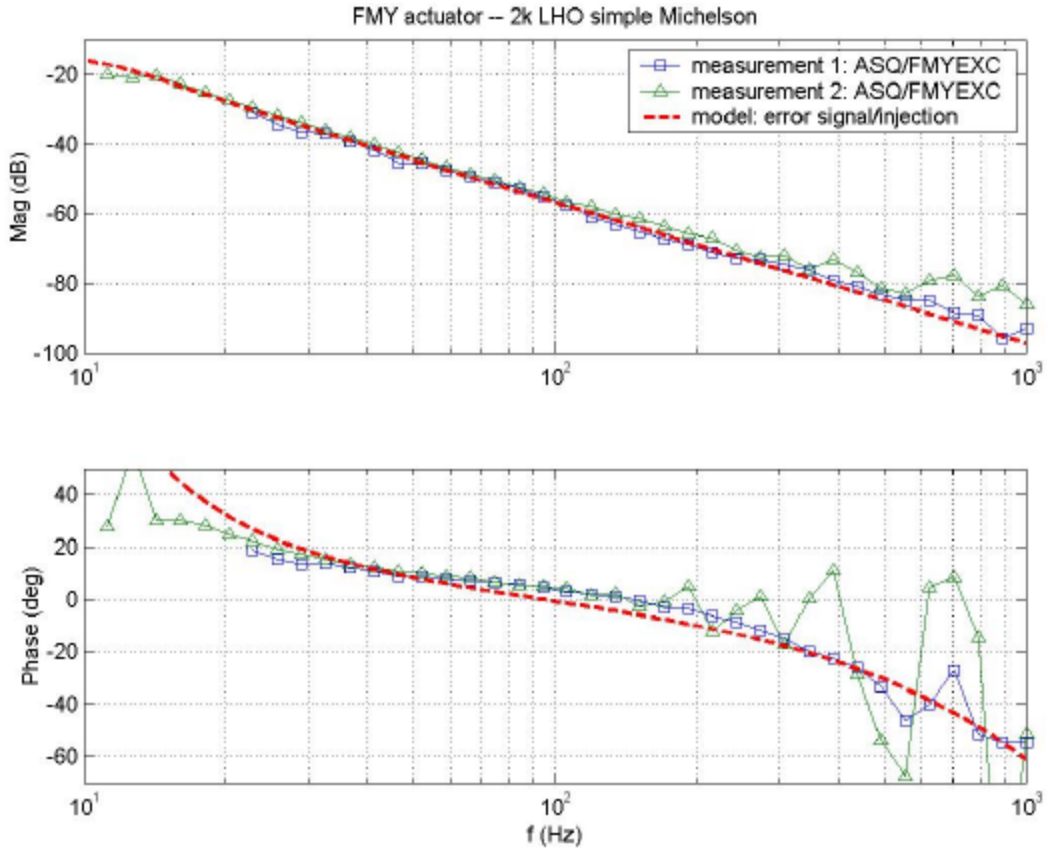
Model Consistent With Observations?

- Simple Michelson
- In-loop measurement
  1. Locking to laser using FMx
  2. Driving FMy
  3. Taking TF e/in
- Model
  - » Having determined DW x AI x H x AA x W
  - » Assuming a pendulum-like TF for Ay and Ax



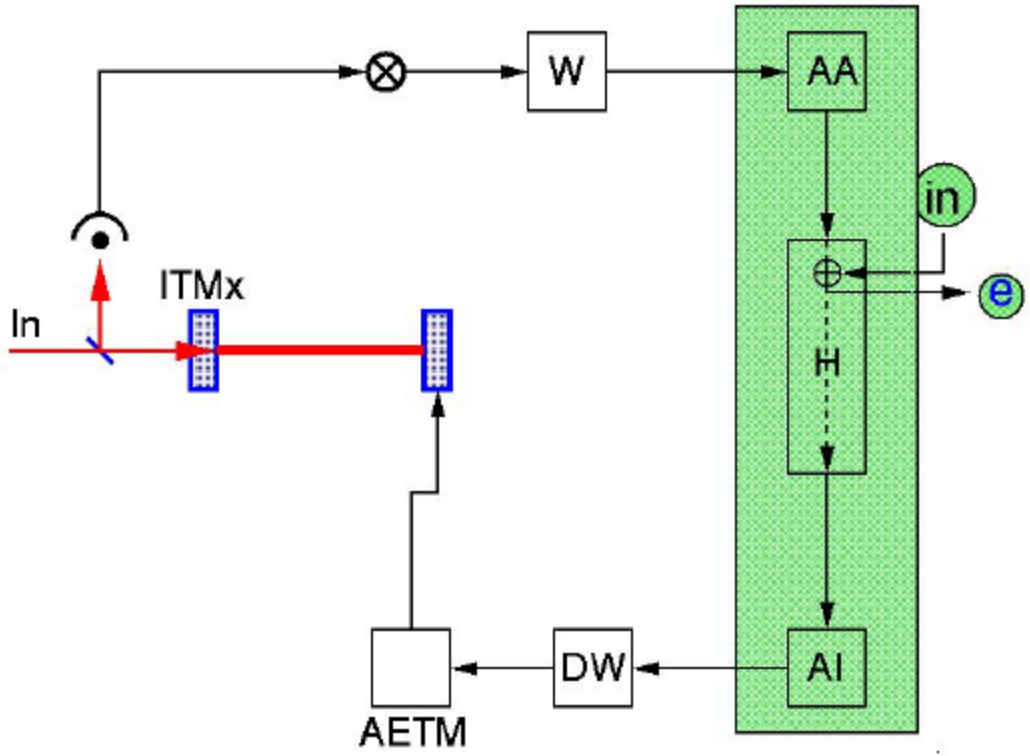
Comparison Model/Observations

- Two measurements of e/in 10Hz -> 1kHz + model output
  1. Magnitude rolls off like 1/f^2
  2. Phase @ 180 deg with
     - Lead at low f due to the closed loop TF
     - Lag at high f due to system delays (computation time + AA)
- NOTE:
  - » no added parameter
  - » adjustment of common gain



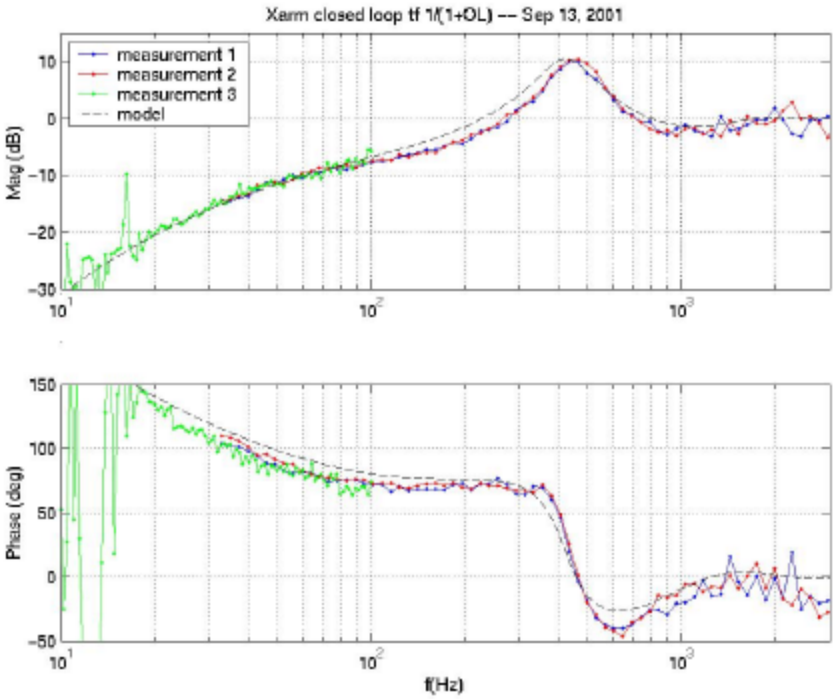
Accounting for the Phase: Setup

- Lock individual arms (X and Y) and measure e/inTF
  - » 1/(1+OL)
- Compare result with expected;

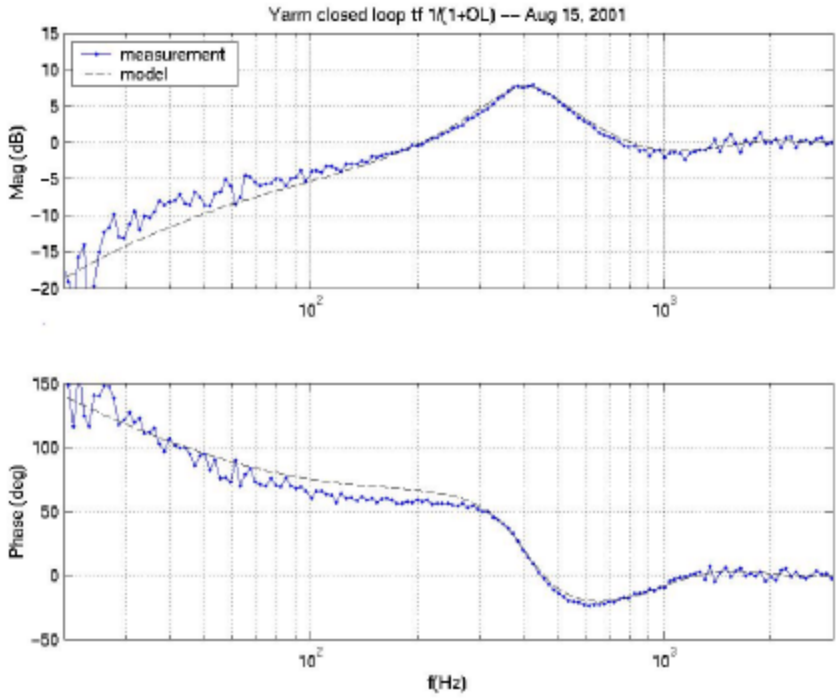


Accounting for the Phase: Comparison Model/Observations

CL TF for the Xarm

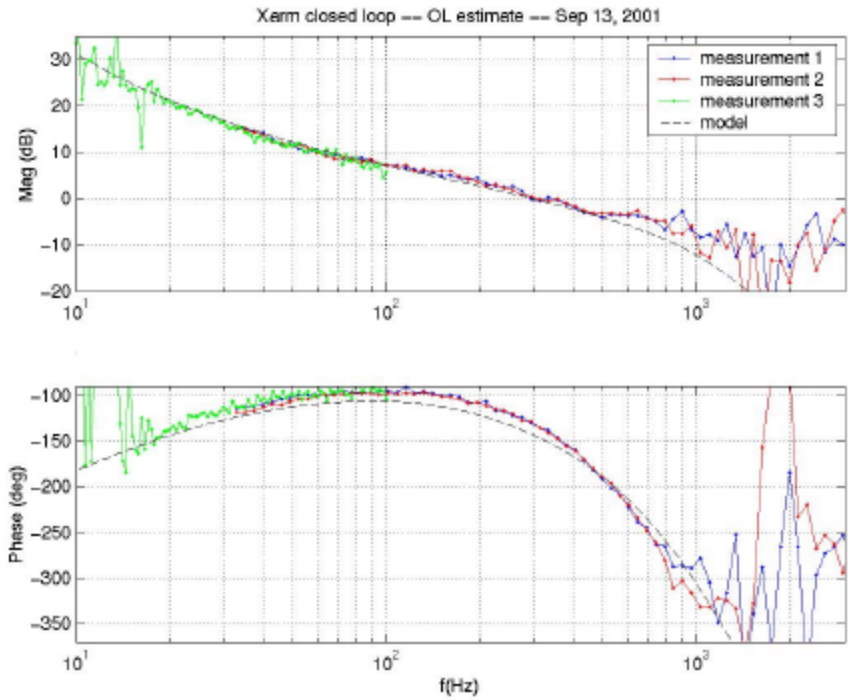


CL TF for the Yarm

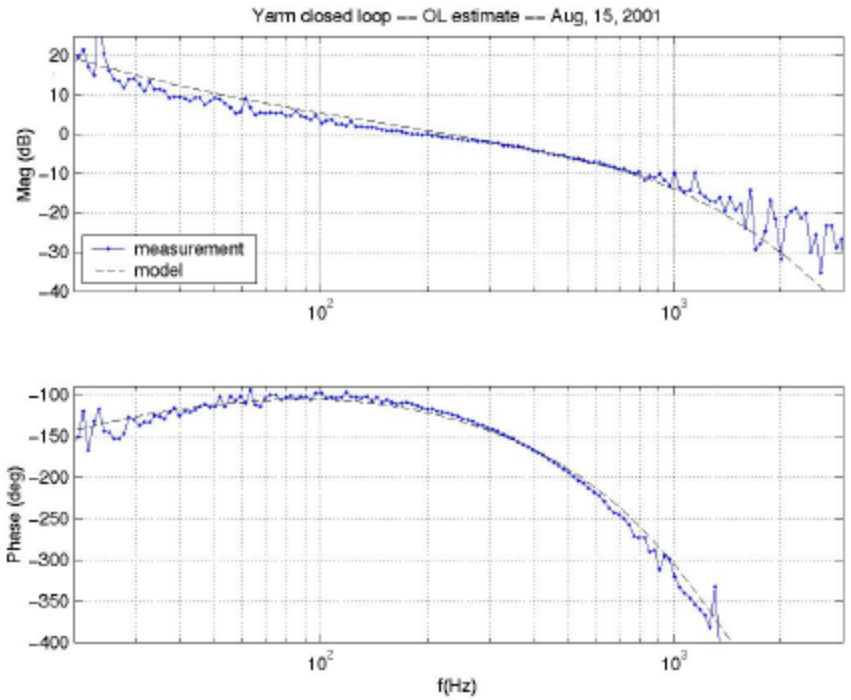


Accounting for the Phase: Comparison Model/Observations

OL TF for the Xarm



OL TF for the Yarm



So, how is the phase distributed within the LSC?

- Filters in use for the arms:
  - .1.1:1,10 & 1k:10,100 & 2kBW
- Phase at 500Hz:
  - s to z-domain: ~10 deg
  - Anti-Imaging: ~8 deg
  - Anti-Aliasing: ~17 deg
  - Delays:
    - Computation: ~15 deg
    - Round trip travel time in fiber: ~4 deg
  - Total: ~52 deg